DEBEADING SCRAP TYRES

The present invention relates to a system and method for removing beads from scrap tyres.

Scrap tyres are made of material that can be re-used and re-cycled for many different purposes. As an example, the rubber content of scrap tyres can be used to form crumb rubber. Demand for crumb rubber is high, with the crumb particle size varying from 50mm^2 down to powder at less than 0.5mm^2. All the requirements for this form of recycled rubber specify that the steel content of the crumb rubber is less than 0.1% and, in fact, substantially zero content in the powder product.

The requirement for low or zero steel content is a problem because all scrap commercial and truck tyres comprise approximately 75% rubber and 25% steel by weight. The steel is in the form of fine steel wire, which is wound into a wire rope and then wound around the tyre. Additionally, a bead of steel wire is provided on each side-wall of the tyre to give the tyre rigidity. Typically the bead is manufactured from high tensile steel wire and nearly always work-hardened. This presents a problem for the cutting tools of the shredding and granulating machinery that is used to form crumb rubber, because it means that they wear relatively quickly and so have to be regularly reground and replaced. This is very costly to the operator, as is the downtime associated with each change of tools. Also, once the tyre with its rubber and steel content is shredded, it is necessary to remove the steel. This means that additional processing is needed.

To reduce the amount of steel, one option is to debead tyres before the scrap tyre is passed to the shredding and granulating machinery. Various methods for doing this are known. In some, the beads are merely torn

from the tyre. However, this often fails to remove all of the bead wire, and because of the manner of its removal, the beads are generally unsuitable for other uses. Also, it is difficult to incorporate a machine of this type into a system for shredding and granulating. This means that additional processing steps are required. In other methods, the beads are machine cut from the tyre. An example of this is described in US 4,914,994, which discloses an apparatus for removing bead wires from a scrap tyre using counter-rotating shearing members. A problem with this technique is, however, that it is expensive and difficult to control.

An object of the invention is to provide an improved apparatus and method for removing the beads from a scrap tyre. Ideally, these should be compatible with the production capacity of the other machinery in the production process.

According to a first aspect of the present invention there is provided a scrap tyre bead removal apparatus comprising a press mechanism for simultaneously removing both tyre beads in a single action.

The press mechanism may include a hydraulic actuator. One or more punch members may be carried on the hydraulic actuator. The punch member may be annular and sized to have a diameter that is slightly larger than that of the outer diameter of the bead. The punch member may co-operate with one or more cutting members to remove the beads. The punch member and the one or more cutting members may be located on opposing sides of a tyre debeading area or platform. Preferably, the or each cutting member has a serrated or scalloped cutting edge.

Preferably, a locating mechanism is provided for locating the tyre in a pre-determined position prior to debeading. The locating mechanism may comprise one or

more locating pieces adapted to engage with an inner surface of the tyre. The locating piece or pieces may have tapered ends for engaging with an inner periphery of the tyre.

Preferably, a tyre conveyer mechanism is provided for moving a tyre into a debeading position. The conveyer mechanism may be an intermittent conveyer mechanism that is configured to move a tyre onto a debeading platform, wait until the tyre is debeaded by the press mechanism and then move the debeaded tyre off the debeading platform. The conveyer may comprise a plurality of spaced apart movable engagement members, such as flight bars, each provided for engaging with a tyre and moving it towards and/or away from the debeading platform.

Preferably a beading conveyer is provided, for example, a belt conveyor, for removing the beads removed from the tyre away from the vicinity of the debeading area.

According to another aspect of the present invention there is provided a method for removing beads from a scrap tyre comprising punching or pressing out the beads.

According to yet another aspect of the invention, there is provided a control system, preferably automatic, for a scrap tyre debeading system, the control system being configured to determine when a tyre is moved to a debeading position; cause a press or punch mechanism to press or punch out the tyre beads, and move the tyre away from the debeading position after removal of the beads.

Various aspects of the invention will now be described by way of example only and with reference to the accompanying drawings of which:

Figure 1 is a cross section of a system for removing beads from a tyre;

Figure 2 is a side view of the system of Figure 1 in a crumb rubber-manufacturing environment, and

Figures 3(a), (b) and (c) are side, end and plan views respectively of the system of Figure 2.

Figure 1 shows a hydraulically actuated press mechanism 10 for punching out the beads 11 from scrap tyres 12. The press mechanism 10 has a hydraulic ram 14, which is movable under the control of a hydraulic power pack (not shown) that includes an electric motor, a pump and valve gear. Arrangements for controlling hydraulic actuators/rams are well known and so will not be described in detail. Carried on the ram 14 is an annular punch member 16 that has an inner diameter that is marginally larger than that of the beads 11 that are to be removed. Also carried on the ram 14 is a locating mechanism 18, fixed to the punch member 16, for locating the tyre 12 so that the beads 11 can be accurately removed. The locating mechanism 18 comprises four symmetrically placed downwardly depending plates 20 that are sized to be a snug fit within the inner rim of the tyre 12. The ends 22 of the plates 20 are inwardly tapered to allow for initial alignment errors. As well as acting to locate the tyre appropriately, the locating mechanism 18 may advantageously be used to secure the punch member 16 to the ram 14.

Opposite the punch member 16 is a cutting mechanism or die 23. This comprises four serrated or scalloped cutting members, which together define a cutting ring. The serrated cutting edge 24 of the die 23 is sized so that it defines a ring that has a diameter that is larger than that of the beading 11. It is positioned to be substantially concentric with the annular punch member 16, and extends through a hole in a debeading platform 26.

In use, a tyre that is to be debeaded should be positioned substantially concentrically with both the hole in the debeading platform 26 and the die 23. Once the tyre 12 is suitably positioned, the hydraulic ram 14 is lowered under the control of the power pack. This causes the locating plates 22 to move into the hole defined by the tyre 12 until the tapered ends 22 of the plates touch the inner circumference of the tyre 12. Continued downward movement causes the locating plates 20 to force the tyre 12 into a pre-determined debeading position. Yet further downward movement causes the punch 16 to press against an upper surface of the tyre 12 so that it is compressed. This causes a lower surface of the tyre to bear against the cutting ring 24, thereby allowing cutting to commence. Downward movement of the ram 14 is continued until cutting is completed and the beads 11 are released from the tyre 12. On completion of cutting, a measurable decrease in resistance and fluid pressure is encountered by the power pack. Once this is detected, the hydraulic ram 14 is retracted, thereby raising the punch 16 and the tapered locating mechanism 18. As will be appreciated the downward force that has to be applied by the ram 14 will vary according to the size and type of tyre to be cut. However as an example, for a commercial vehicle tyre, the force may be in the range of up to 45 tonnes.

Figures 2, 3(a) and (b) show the punch mechanism 10 of Figure 1 in a manufacturing environment. On opposing sides of the punch 10 are stationary or fixed platforms for supporting scrap tyres, one 28 being for carrying a scrap tyre before debeading, referred to as the input platform, and the other 30 being for carrying the tyre after debeading, referred to as the output platform. To drive the tyres along these platforms, an intermittent

drive conveyor is provided. The intermittent drive conveyer has two endless chains 32 that are spaced apart by a plurality of flight bars 34 that are connected to the chains 32 at intervals appropriate to the required pitch of the scrap tyres. Each endless chain 32 extends round opposing positioning sprockets 36 that are located at the ends of the input and output platforms 28 and 30, so that they, and the flight bars 34, can be moved round an endless path. The endless chains 32 can be driven by any suitable mechanism, although a hydraulic drive 40 is preferred.

Figure 3(a) shows an example of the hydraulic drive 40, which ideally is controlled by the same power pack 42 as is used for controlling the punch mechanism 10. The drive 40 has a piston 44 with a latch 46 fixed to its end. The piston is positioned below and substantially parallel to the input platform 28. The latch 46 is adapted to hook onto one of the flight bars 34 when it is moved in a forward direction. To accommodate this, a slot (not shown) is provided along the input platform 28. Because of the contact between the latch 46 and the bar 34, movement of the piston 44 in a forward direction causes movement of the bar 34 towards the debeading platform 26 by an amount that corresponds substantially to the stroke length of the piston 44. When the piston 44 is retracted the latch 46 is moved rearwardly until it is located behind the next one of the bars 34. To allow for the fact that there would typically be a tyre in the rearward path of the latch 46, the latch 46 is pivotally, spring mounted on the piston 44, so that in its normal state it is biased in a substantially up-right position to engage with the flight bars 34, but it is pivotable forwardly against the action of the spring when it is moved rearwardly and hits against the rear tyre. Of

course, any other suitable latch mechanism could be used, for example a cam based mechanism.

In addition to the intermittent conveyor, a bead conveyor 48 is provided, typically a standard belt conveyor. As shown in Figures 3(a) and (c), this extends from below the tyre debeading platform 26 to an area away from the punch 10. Because of the nature of the punch mechanism in which the invention is embodied, the beads removed from the tyres are generally in good condition, substantially maintaining their circular cross-section. This opens the possibility that the beads could be re-used. Hence, the bead conveyor 48 may be positioned so as to convey the beads to another part of the manufacturing facility for further processing. Typically, the bead conveyor 48 would be running continuously.

To control the intermittent conveyor and the punch 10, a control system 50 is provided. This is typically PC based. Where a single power pack 42 is used to power the hydraulic ram 14 of the punch and the piston 44 of the intermittent conveyor, the control system 50 is either connected directly to this pack or incorporated within it. The control system 50 is operable to ensure that the punch mechanism 10 is not activated until a tyre is accurately positioned on the debeading platform 26. This can be established by monitoring the position of the piston 42 and/or using some form of sensor located on or near the debeading platform 26 and configured to sense the presence of a tyre. The control system 50 is also operable to activate the intermittent conveyor to cause a debeaded tyre to be moved off the debeading platform and another tyre to be moved onto it.

In use of the system of Figures 2 and 3, movement of the tyre 12 onto the input platform 28 is timed and arranged so that each tyre 12 is positioned between two

of the flight bars 34. Each tyre 12 is driven along the input platform 28 towards the punch by movement of the rear bar 34, which in turn is caused by engagement with the latch 46 and movement of the piston 44. In this way each tyre 12 can be moved in sequence on to the debeading platform 26. Once each tyre is located on the debeading platform, the control system causes the chain drive to temporarily stop by either stopping movement of the piston 42 or causing it to move rearwardly and so move the latch 46 out of pushing engagement with one of the bars 34. The beads of the tyre 12 located on the cutting platform 26 are then removed by the punch mechanism 10, as described previously. The released beads 11 fall through the inner circumference of the die 23 and onto the bead conveyor 48. At the same time, the punch mechanism 10 is retracted, and the control system 50 causes the intermittent conveyor drive mechanism to restart. This causes the debeaded tyre to move on to the output platform 30, and the next tyre that has to be debeaded to move onto the debeading platform. The debeaded scrap tyre is then suitable for shredding in downstream machinery with a reduced detrimental impact on the tools. Using the arrangement of Figures 2 and 3 this can be done at a controlled rate that is consistent with such machinery.

The system in which the invention is embodied have many advantages. Most notably, the system provides an effective, fast and economic means for debeading scrap tyres. This is useful for the manufacture of crumb rubber. A further advantage is that the beads removed from the tyres are substantially unscathed by the process and so maintain their shape. This means that the beads could be used as a component in another product. For example, it is envisaged that the beads removed using the

punch mechanism could be used to make metal tubes. Since tyre bead steel is work hardened and so very strong, these metal tubes could be used for heavy-duty applications. In addition, the beads can be used as raw material for other products.

A skilled person will appreciate that variations of the disclosed arrangements are possible without departing from the invention. For example, whilst the punch mechanism is described as operating in co-operation with a cutting mechanism that is positioned opposite it, the punch itself could be shaped so as to define a cutting edge. Accordingly, the above description of a specific embodiment is made by way of example only and not for the purposes of limitations. It will be clear to the skilled person that minor modifications may be made without significant changes to the operation described.